NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

Conserve O Gram

August 1998 Number 3/8

Controlling Insect Pests: Alternatives To Pesticides

This *Conserve O Gram* is an overview of techniques that can be used instead of pesticides when a pest infestation is found in collections. It will help you decide on an appropriate treatment when a pest infestation is found in collections. Other *Conserve O Gram* leaflets will provide in-depth information on the techniques described here that can be adapted for use in parks and small museums. Treatments such as these should only be considered as part of an overall Integrated Pest Management (IPM) strategy to protect collections. See NPS *Museum Handbook,* Part I, Chapter 5, Biological Infestations for a description of developing an IPM strategy for museum collections.

Even with IPM, infestations can occur. When infestations are discovered, choosing the pest control method best suited to a particular problem can be a difficult decision. Prevention is always better than the cure, but when pests are found in objects or in the building some remedial action may be necessary. When you find pests:

- Isolate any objects suspected of being infested to prevent spread of infestation to other objects. Some objects can be sealed in polyethylene ziplock bags for monitoring and to prevent insects from spreading.
- Identify the pest and its biology (life cycle and behavior).
- Clean infested areas and destroy insect bodies and debris.
- Decide on the most appropriate treatment for the object and environment.

Consideration must be given to the object's general composition and condition and so consult with a conservator before deciding what to do. The use of an inappropriate method can cause damage to collection materials and serious health hazards to the staff and public.

Because of the health and environmental risks posed by the use of poisonous fumigant gases there has been a great deal of effort in the museum world to search for safe and effective alternatives. Each of the following options to the higher risk toxic fumigants have advantages and disadvantages which must be carefully evaluated in light of the type of the collections, the individual situation and the resources available.

Temperature Treatments

Low temperature. Freezing kills insects by rapid temperature change. This technique is described in detail in *Conserve O Gram* 3/6. It is a widely used treatment for many objects such as natural history specimens and textiles but, unless proper procedures are observed, some damage can occur to objects. Composite, fragile or unstable materials should not be subjected to extremes of temperature.

Temperatures in the freezer should be -18°C or below (Strang, 1992). It is better to use a deep freeze unit rather than a common household freezer and self-defrosting freezers should never be used. The freezer should be capable of reducing the temperature in the objects within 24 hours to be effective. If the items are stored in a cold climate and then frozen very slowly, some insects will become acclimated and will not succumb to freezing. It may take much longer for the cold to penetrate large objects or tightly rolled tapestries and skins. The temperature in the center of test materials should be recorded to

check that the target temperature has been achieved. It is not advisable to freeze wet specimens unless this is to prevent bacterial and fungal decay.

The objects must be sealed in polyethylene plastic bags prior to freezing to prevent damage by RH changes and moisture migration. An absorbent organic buffering material, such as acid-free paper, can be added to the bag to help control the RH. In the past it was thought a double freezing at -18°C was necessary to kill all stages of insects but more recent work (Strang, 1996) has shown that a single exposure for at least 2 weeks at -18°C will kill all of the pest species. If the freezer can reach colder temperatures (-30°C) an exposure of at least 3 days should be enough.

When removed, objects must not be unsealed from the bags until they have reached room temperature to prevent condensation on the object. However, if there are many insects in the building then objects can be left in the polyethylene bags to provide some protection from further insect attack.

Heating. Heating will kill insects much more rapidly than freezing but it is essential to ensure that elevated temperatures do not harm objects. In the past a number of museums used ovens to disinfect insect collections and this often resulted in brittle specimens and cracked storage drawers. Recent work has shown that damage due to shrinkage and distortion can be eliminated by controlling the humidity around the object (Strang, 1996). If objects are bagged when they are heated to 55°C then humidity in the enclosure is stable and the object is not damaged. As with low temperature treatments, it is inadvisable to subject composite, fragile, or unstable materials to extremes of high temperature. This method offers possibilities in the near future for rapid and safe treatment of some objects. Until specific techniques are developed and published heat treatment should not be used except with guidance from a conservator with experience in heat treatment.

Microwaves have been used for rapid treatment of books, papers and herbarium specimens but there can be undesirable side effects as the heating may be uneven and localized overheating may occur. In addition, unnoticed metallic objects such as paperclips may cause sparking and ignition of specimens and paper. This technique is not considered safe for use with museum collections.

Modified Atmosphere Treatments

Modified atmosphere treatments have been developed as a direct replacement for fumigation with toxic fumigants and the techniques and procedures used are in some cases very similar.

Anoxia. The procedure kills insects by the exclusion of oxygen (anoxia), and therefore oxygen levels must be very low, less than 0.1%. This can only be achieved in an airtight chamber, or in individual bags made of a special oxygen barrier film. The speed of the treatment in killing insects is dependent upon temperature, at temperatures of 25°C and above, 2 to 3 weeks should be sufficient to kill pests. However, at temperatures of 20°C or below, very long exposures of 4 or 5 weeks may be needed to kill some species such as woodborers.

- Large objects can be treated using nitrogen from cylinders.
- Small objects can be treated in sealed bags using an oxygen scavenger such as Ageless™ (produced by the Mitsubishi Gas Chemical Company).

Nitrogen. Nitrogen has proven to be a very effective and safe method for treatment of sensitive objects (Hanlon, et. al., 1992; Rust et. al., 1996). Building a nitrogen treatment chamber may be expensive because of the need for absolute gas-tightness. Conversion of an existing fumigation chamber used for ethylene oxide or methyl bromide is feasible but also can be expensive because of the need for additional sealing and pipework. A cylinder and bag

method is less expensive to set up initially. An accurate oxygen meter must be purchased and gas cylinders must be stored in compliance with local fire and safety regulations. An important consideration is that the relative humidity (RH) of nitrogen gas is less than 5%, which would be detrimental to the materials being treated. It is therefore essential to add a simple humidification system to the gas supply line (Rust et. al., 1996). This technique is probably beyond the resources and needs of most small museums.

Ageless™. A number of museums now use Ageless, a scavenger of gaseous oxygen for treatment of individual specimens (Gilberg, 1989, 1990; Lambert et. al., 1992). Ageless is composed of moist, active, iron oxide powder encased in a porous packet. Oxygen in the atmosphere penetrates the packet and further oxidizes the powder. A slight amount of heat and moisture is produced by the reaction, but if the packets are spaced apart and kept out of contact with objects then heat and moisture do not build up enough to damage the material being treated. The small amount of additional moisture will have no measurable effect on well-buffered absorbent materials such as textiles or natural history specimens but it is better to wrap more sensitive non-absorbent material in buffering cloth or acid-free tissue paper.

Ageless will work most effectively only by enclosing the object to be treated in a bag made from a special oxygen barrier film. It is useless to use ordinary polyethylene, as this is porous to oxygen. The bag should be big enough to accommodate the object to be treated with a few inches excess, which will become the seam of the bag when it is heat-sealed. The number of Ageless packets to be used should be calculated from the type of packet and the volume of the bag. An indicator called "Ageless Eye" can be used to show that levels of below 0.1% oxygen have been achieved. Objects should be left for at least three weeks at 25°C to kill all stages of insect pests. With this system, set-up costs are lower than with the cylinder treatment but costs of Ageless may be high if large objects are treated. Some museums use a combination of nitrogen flushing and Ageless for treatment of large objects. Ageless will also slow any degradative processes requiring oxygen, such as mold growth or oxidative chemical reactions. Other types of Ageless will absorb both oxygen and moisture and therefore have applications for collection care other than insect eradication. Small museums can use Ageless to treat individual objects. The technique will be described in detail in a separate *Conserve O Gram* leaflet.

Carbon dioxide. Carbon dioxide treatment has been widely accepted in the food industry for many years and the technique has been adapted for use by museums. The treatment procedure used for CO_2 is similar to that used for nitrogen in chambers or bubbles (Valentin & Preusser, 1990). As with nitrogen, the gas works slowly, particularly at low temperatures and some treatments add slight heating of the chamber to 30°C to increase insect metabolic rates. This method also requires use of a meter to monitor the percentage of CO_2 in the chamber during the exposure period. Levels of CO_2 need to be about 60% and unlike nitrogen, the treatment is effective even with some leakage of oxygen into the enclosure. Because of this, CO_2 is far more practical than nitrogen for treatment of large objects and enclosures. However, it is important to check on local safety procedures and regulations before proceeding, as there may be some restrictions on the use of this treatment in some states. There have been some concerns that CO_2 will react with water to produce carbonic acid but there is no evidence that this will happen at the usual range of humidities and moisture contents used for treatment of museum objects. Contact your IPM coordinator or local pest control company for more information about the use of CO_2.

Other gases. Argon and other inert gases have been used with varying degrees of success but

because they are more expensive than nitrogen or carbon dioxide, it is difficult to justify their use.

After Treatment

Remember, once the treatment is completed, the object should be periodically monitored for pest activity to ensure that all insects have been killed and care must be taken not to allow the material to become re-infested. Keep treated and pest-free objects separate from actively infested materials or storage areas. In cool and dry storage areas, objects that are particularly susceptible to insect attack can be left in clear polyethylene or heat-sealed bags to prevent them from being re-infested.

References

Child, Robert E. "The Thermo Lignum Process for Insect Pest Control," *Conservation News* 72, (1994).

Gilberg, Mark. "Inert Atmosphere Fumigation of Museum Objects." *Studies in Conservation* 34, (1989).

Gilberg, Mark. "Inert Atmosphere Disinfestation Using Ageless™ Oxygen Scavenger." *9th Triennial meeting*. ICOM, Committee for Conservation, 1990.

Hanlon, Gordon; Daniel, Vinod; Ravenel, Nancie; and Maekawa, Shin. "Dynamic system for nitrogen anoxia of large museum objects: a pest eradication study," *2nd International Conference on Biodeterioration of Cultural Property, Yokohama, Japan*, 1992, (1992).

Lambert, F.L.; Daniel, V.; and Preusser, F. *The Rate of Absorption of Oxygen by Ageless; The Utility of an Oxygen Scavenger in Sealed Cases.* Getty Conservation Institute, Marina del Rey, CA, 1992.

National Park Service. "Biological Infestations," *Museum Handbook*, Part I, Chapter 5. Washington, D.C.: National Park Service, Museum Management Program, 1990.

Pinniger, David B. *Insect Pests in Museums*, 3rd edition, London, UK: Archetype Press, 1994.

Raphael, Toby. "An insect pest control procedure: the freezing process," *Conserve O Gram* 3/6, National Park Service, 1994.

Rust, Michael K.; Daniel, Vinod; Druzik, James R.; and Preusser, Frank D. "The feasibility of using modified atmospheres to control insect pests in museums," *Restaurateur* 17, (1996).

Strang, Tom J.K. "A review of published temperatures for the control on museum collections," *Collection Forum* 8, (1992).

Strang, Tom J.K. "The effect of thermal methods of pest control on museum collections," *3rd International Conference on Biodeterioration of Cultural Property, Bangkok, Thailand 1995,* (1996).

Valentin, N. & Presseur, F. "Insect Control by Inert Gases in Museums, Archives and Libraries," *Restaurateur* 11, (1990).

D.B. Pinniger
83 Westwood Green
Cookham, Berks SL6 9DE
UK

The series is distributed to all NPS units and is available to non-NPS institutions and interested individuals by subscription through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; FAX (202) 512-2250. For further information and guidance concerning any of the topics or procedures addressed in the series, contact NPS Museum Management Program, 1849 C Street NW (NC230), Washington, DC 20240; (202) 343-8142.